Section 3: Analysis of the Risk Framework

Disclaimer: **This draft report was prepared to help the Department of Energy determine the barriers related to the deployment of new nuclear power plants but does not necessarily represent the views or policy of the Department.**

Approach to the Risk Framework, Industry and Financial Interviews, and Roundtables

Applying a Risk Mitigation Approach to Investment Decisions Regarding Nuclear Power

- NE traditionally has focused on the future of the nuclear power industry in terms of critical issues in the areas of technology development, regulation of nuclear power generating facilities, and economic demand for power.
- In examining the drivers behind private-sector investment in new nuclear power generating facilities, NE is concerned with increasing its understanding of the risks associated with such investment and methods for risk mitigation.
- This section of the report focuses on (a) an articulation of the most critical risks impacting investment decisions and (b) the identification of a variety of potential risk mitigation mechanisms that government and the private sector might apply.
- The analytical approach used herein has been to identify these risks, characterize them, develop a strong understanding of the issues which impact a particular risk, and then assess their relative significance to investment decisions in new nuclear power plants.
- We obtained a great deal of information from interviews with senior executives in both the broad nuclear power industry and the financial community. We then conducted two roundtable discussions with selected executives who participated in the interview process to develop a strengthened understanding of the private sector's capabilities and shortfalls in mitigating nuclear power development risks.
- Finally, having identified which risks are most intractable and the areas in which the private sector is least capable of developing its own risk mitigation capability, we considered possible federal programs and financing mechanisms that would leverage private sector investment and risk management capability.
- The following slide depicts the identifies the critical risks in two groupings:
  - The first group lists three risks (disposal, accident, and regulatory) that are considered "show stoppers", i.e., risks that, if not sufficiently mitigated, will prevent a new nuclear generation project investment decision from going forward.
  - The second group lists other critical risks that industry and financial participants identified as significant concerns. Most of these risks can be only partially mitigated through private sector mechanisms, at least for early new plants.

  Mitigation mechanisms are discussed beginning on page 5-36.

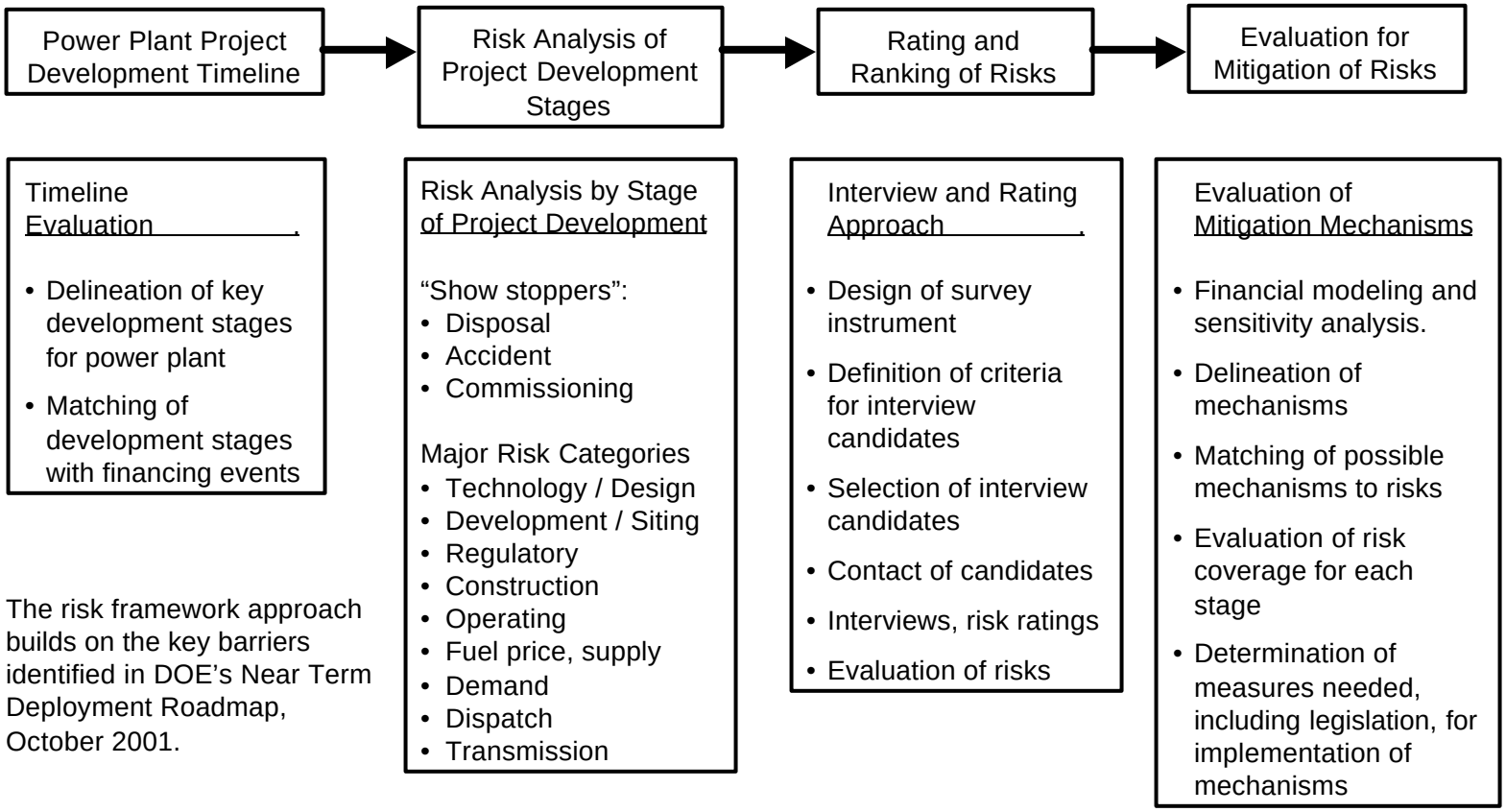
Risk Analysis Framework

Major risks fall in two categories. Mitigation mechanisms require both private sector and government participation, as discussed later in this section.

Risk Issue	Mitigation Mechanisms	
	Private Sector Solutions	Government Solutions
"Show-stopper" Risks		
Disposal		
Accident		
Commissioning		
Critical Risks		
Regulatory		
Technology / Design		
Development / Plant siting		
Construction		
Operating		
Fuel price and supply		
Demand		
Dispatch		
Transmission availability		

Overview and Approach to the Risk Framework

This diagram depicts the logic flow and approach to the analysis contained in the study.



The risk framework approach builds on the key barriers identified in DOE's Near Term Deployment Roadmap, October 2001.

Risks Identified in New Nuclear Power Plant Development and Financing

- The following specific areas of risk were identified by industry and the financial community as important to their evaluations as they make decisions related to potential new power plants:

Risk Areas

- Waste disposal**: Risks that costs for disposing of spent fuel and, to a lesser degree, low-level waste will be higher than anticipated (e.g., for alternatives to storage at Yucca Mountain).
- Accident**: Risk of third party liability with respect to the costs of remediation and recovery after a major accident, *force majure*, or terrorist incident.
- Commissioning or Licensing**: Risk of costs of an extended construction period, commissioning delays, or a complete stop to operations because of an intervention (e.g., a lawsuit).
- Regulatory (NRC / DOE): Risks of additional costs arising from a shift in regulations that affects siting, construction, operations, and security.
- Technology / Design: Risks associated with failure or below-grade operating performance due to faulty design of the reactor and balance of the plant system.
- Development / Plant siting: Risks and costs related to getting a new reactor sited and prepared for construction, including specific site designs.

** Three risks—Disposal, accident, and Commissioning —were identified as "show stoppers", meaning that they must be dealt with *fully*, or no new plants will be ordered.

Risk Areas (continued)

- Construction: Risk of cost or schedule overrun related solely to construction, labor (including strikes), and materials, not regulatory or financing activities.
- Operating: Risk of increased costs due to poor or inefficient management, operation, and maintenance of the reactor (not including design or technology failings).
- Fuel price, supply: Risk of losses or higher operating costs due to fuel price spikes or supply interruptions that lead to downtime or sub-par performance.
- Demand: Risk of lower revenues because long-term regional demand for electricity does not materialize at a level enabling full utilization of the plant.
- Dispatch or Market: Risk of revenue loss and of not covering sunk costs because the plant is not competitive given prevailing rates for electricity in local markets.
- Transmission availability: Risk of lost revenues due to transmission constraints reducing off-take of the plant's power production.

Approach to Industry and Financial Interviews and Roundtables

- The target participants for the interview phase of the study fall into three groups:
  - Participants from the nuclear power industry, including the nuclear power divisions of integrated generation and distribution companies, vendors of nuclear reactors, and construction companies that are involved in the engineering and construction of nuclear power plants.
  - Participants from the financial community, including equity investors (e.g., investment banking firms), providers of debt capital (e.g., bank lending institutions), and insurance underwriters. In each firm, we identified senior individuals who are directly involved in financing nuclear power, either as project or corporate lenders or as investment bankers with product line responsibility for project finance to the power industry or coverage responsibility for integrated generating and utility companies or for independent power project developers.
  - In addition, we included equity research analysts and fixed income credit research analysts who provide research to investors in either equity or debt instruments issued by integrated generating and utility companies or independent power project developers.
  - Participants from the non-governmental organization (NGO) community with a specific focus on nuclear power issues.
  - Both industry participants and financial community participants were interviewed. In certain instances, interviews were conducted with multiple members of a given organization, particularly if they have different roles in nuclear power projects.
  - Separate questionnaires were developed for the industry and financial interviews; they were tailored to address the issues, concerns, and perspectives of each group. The industry questionnaire was used in NGO interviews since many of the issues relevant to industry's role as operator of nuclear power plants are followed by the NGOs. The questionnaires are summarized in the following slides.
- Industry and financial community participants came together in two three-hour-long roundtable discussions to share their views and comments on important issues raised in the interviews. The "Industry Roundtable" was held in Washington, D.C., on May 6, 2002, and the "Financial Community Roundtable" was held on May 9, 2002, in New York City.
  - Senior officials from NE participated in both the industry and financial community roundtables.
  - Nuclear Regulatory Commission (NRC) Chairman Richard Meserve participated in the "Industry Roundtable".

Topics Covered in Industry Interviews

- Interviews were organized around the risk framework to facilitate evaluation of the key barriers to new plants:

General Outlook

- What is the current outlook for orders of a nuclear plant (by 2005 – 2010), as you see it? By 2020? By 2025?
- Which regions will likely have the first successful ESPs?

Specific Technologies (light water reactors [LWRs] and gas-cooled reactors)

- Which of these do you believe are the best candidates?
- How soon can the various designs be brought to market, and what are the major hurdles for each?
- What role(s), if any, should DOE play?

Regulatory Issues

- What progress do you see on Early Site Permit (ESP) process?
- How may the COL + ITAAC regulations help?
- Is offering a federal site for a first prototype helpful?

Construction

- Can U.S. engineering firms build nuclear plants on time and on schedule?

Operating

- How confident are you that new nuclear units can attain the capacity factors reached recently by the current fleet of U.S. reactors?

Fuel Price, Supply

- Is nuclear fuel price and supply an issue now? By 2010?
- What about fabrication of fuel for PBMRs, gas reactors?

Disposal

- Will Yucca Mountain open? What are the alternatives?

Electricity Demand Uncertainty

- Are we in a boom–bust cycle of power plant construction? What is the most likely role for nuclear power in 2010?

Dispatch Competitiveness

- Will nuclear power really compete with gas-fired capacity? Will it continue to meet baseload demand?

Transmission Availability

- Will adequate transmission capacity be available for nuclear plants?

Financing

- What approaches to financing new plants are utilities contemplating (e.g., balance sheet, project finance)?
- What debt and equity terms are contemplated?

Accident

- How do you rate the prospects for accident risk?

Topics Covered in Financial Interviews

- Interviews were organized around the risk framework to evaluate the key barriers to proceeding with new plants:

Development, Regulatory, and Construction Risks

- What do you believe are the critical risks in licensing, design, and construction of new nuclear power plants?

Demand for New Plants

- How many new nuclear power plants do you believe will be developed over the next 10 years and at what capacity?

Capital Formation Strategies

- What capital formation strategies and structures do you believe will be used for new nuclear power plants?

Economic Competitiveness

- How competitive are the underlying economics of power production at new reactors?

Operating Risks

- Which financial or business risks must be mitigated to achieve commercial operation of new nuclear plants?

Risk Mitigation Strategies

- What risk mitigation strategies would you suggest be considered for addressing hurdles or implementation barriers?

Financing Alternatives

- Suggestions for alternative federal financing mechanisms or actions to increase the viability and competitiveness of early orders for new nuclear power facilities.

Industry and Financial Participants

Utilities

Constellation Energy
Dominion Resources
Entergy Nuclear
Exelon
Southern Nuclear
Tokyo Electric Power

Engineering & Construction

Bechtel Nuclear
Sargent & Lundy

Electricity Grid

PJM Interconnect

Reactor Systems & Services

Framatome ANP
GE Nuclear
BNFL Westinghouse Nuclear
General Atomics

Government

Nuclear Regulatory Commission

Financial Community

ANZ Investment Bank
Citibank
Credit Suisse First Boston
Credit Lyonnais
Deutsche Bank Securities
Goldman, Sachs & Co.
Lehman Brothers
Merrill Lynch
Morgan Stanley & Co.
Zurich, U.S.

Non-Governmental Organizations

National Defense University
Natural Resources Defense Council
Nuclear Control Institute
Union of Concerned Scientists

Current Climate for New Power Generation Investment and Financing

Issues Affecting Industry Participants

- This study was conducted during a period of significant overcapacity in power generation in the U.S. market.
- None of the industry participants currently contemplate adding significant amounts of new generating capacity. In fact, over 80,000 MWe out of a total of 250,000 MWe of planned generating capacity (nearly all gas-fired) has been cancelled or postponed since September 11, 2001 (source: Platt's).
- Some forecasts indicate that these conditions may continue through 2007, and many planned plants could be delayed to 2010 – 2011. Yet, economic projections indicate that some 300,000 MWe of new power plants will be needed in the United States by 2020, adding to a current base of nearly 800,000 MWe (source: EIA).
- Uncertainty with respect to deregulation also negatively affects generation investment decisions, as states and regional power market organizations evaluate and reevaluate their deregulation policies, as deregulation continues to impact electricity prices in several regions, and as the potential continues for further changes in the future.
- Near-term supply overcapacity conditions will make it difficult for industry CFOs to justify investing in new large baseload power plants.

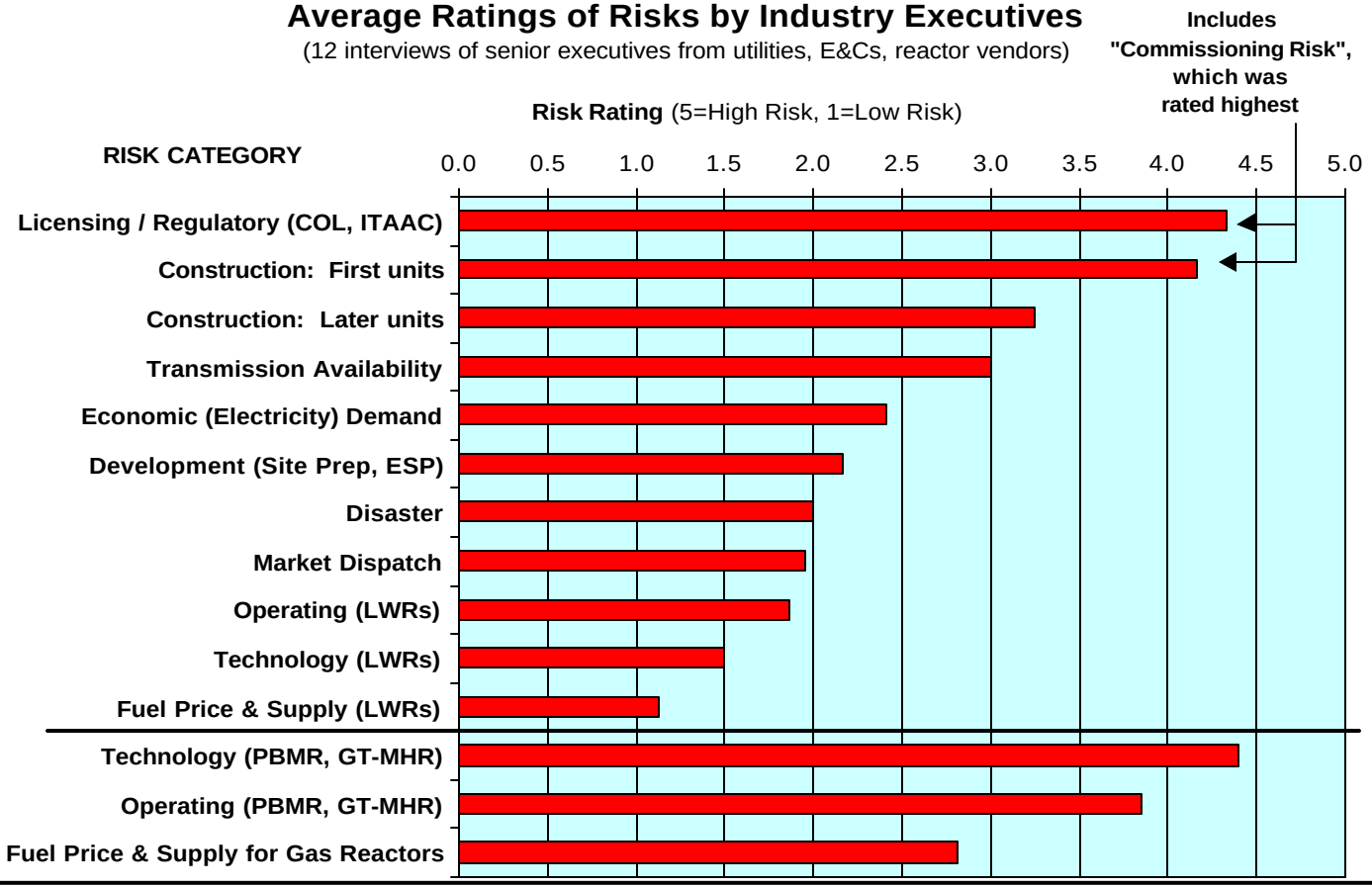
Issues Affecting Financial Participants

- The conditions affecting industry are directly reflected in the views expressed by the financial community and by the non-existent deal flow for new nuclear capacity.
- Acquisition financing for asset transfers of generating facilities and mergers of utilities and generating companies is the dominant form of financing activity in a period of decline in credit quality in the power sector.
- Financial markets have also been negatively impacted by the evolution of the California power crisis, which created an exacerbated sense of uncertainty with respect to power prices in the Western region of the United States.
- The PG&E insolvency, the Enron bankruptcy, and ongoing turmoil in grid pricing have resulted in increases in bank loan loss reserves and in the need to evaluate each bank's and each institutional investor's exposure to a number of the largest players in the power sector.
- Lenders typically make credit approval decisions based on engineering studies and economic data, the conclusions of which are used to gauge demand for new capacity.
- Financial analysts traditionally are skeptical about projections for new electricity demand beyond a 5-to-10 year horizon.
- While demand is down, many lenders have chosen to remain on the sidelines with respect to additional exposure to the power generation sector.

Findings from Industry

Industry Ratings of Risk Categories

This bar chart provides average ratings by industry executives of the critical risk categories. The ratings are on a 5-point scale, with "1" indicating a low risk and "5" a high risk. "Construction" risk includes "commissioning" risk, which is the risk that a new plant will suffer delays in producing power, even after construction is completed, or will never produce power. Ratings for gas-cooled reactors are separated at the bottom of the chart because they are farther from commercial use.



Industry Perspectives on Disposal Risk

Description of the Risk

- Waste disposal**: Risks that costs for disposing of spent fuel and, to a lesser degree, low-level waste will be higher than anticipated (e.g., for alternatives to storage at Yucca Mountain).

Risk Rating

- Industry executives rated waste disposal as a "show-stopper" risk.

Results from Interviews

- Utility executives were unanimous in their view that proceeding with the Yucca Mountain licensing and construction process is paramount for new nuclear plant orders to be placed and to handle the current and projected volume of spent fuel.
- A majority approval in both chambers of Congress is required by July 2002 to override the veto of the Yucca Mountain repository by the governor of Nevada so that licensing and construction can go forward. Executives see the vote on Yucca Mountain as a bellwether indicator for political support for nuclear power. The House voted to override the veto by a 306 – 117 vote on May 8. The companion bill in the Senate was approved, 60 – 39, on July 8, thereby overriding the governor's veto.

Results from Interviews *(continued)*

- Executives noted that waste and fuel are being transported across the country safely now.
- Waste space for low-level waste (e.g., rags, boxes, gloves) was seen as a low level issue by everyone. Annual volumes produced have been reduced to nearly 300,000 cubic feet from ten times that volume in 1982. Envirocare, a commercial hazardous waste site in rural Utah, wields a huge surplus of space for low-level waste.

Illustrative Quotes

- **Utility Executive:** "No doubt about it. Yucca Mountain is a 'show-stopper' issue."
- **Nuclear Operator:** "This is a go / no go criteria for next reactors. The decision on Yucca is a clear indication of political will about the future of nuclear power."
- **Utility Executive:** "Yucca will likely get open eventually. If it does not, then DOE is still on the hook legally to provide an answer."
- **Utility Executive:** "To build new plants, Yucca Mountain or a similar solution would have to be resolved, along with the transportation issues (political, not technical). It could still be difficult to overcome the political issues associated with transporting spent fuel."

** Denotes "show-stopper" risks.

Industry Perspectives on Accident Risk

Description of the Risk

- Accident**: Risk of third-party liability with respect to the costs of remediation and recovery after a major accident, *force majure*, or terrorist incident.

Risk Rating

- Industry executives rated accident risk as a "show stopper".

Results from Interviews

- Utilities expect that, in 2002, Congress will reauthorize Price-Anderson Act coverage through 2012. It is not clear to these executives whether there are any alternatives if Price-Anderson is not reauthorized.
- Utility executives commented that the public does not understand that Price-Anderson coverage is limited, noting that utilities must provide a matching premium and are responsible for accident consequences up to a certain level.
- They also note that Price-Anderson addresses third-party liability, not the cost of radioactive cleanup at the utility site. Utilities are liable for these cleanup costs at their site.

Illustrative Quotes

- **Utility Executive:** "The average voter thinks Price-Anderson is a free ride. It is not. It costs us millions of dollars to provide our matching portion of the coverage."
- **Utility Executive:** "There is a financial guarantee portion for utilities in Price-Anderson coverage (costing about $90 million). Price-Anderson is not a free ride for utilities; some costs and liabilities are not covered by Price-Anderson that are borne by utilities."
- Commissioning** and Licensing: Risk of costs of an extended construction period, commissioning delays, or a complete stop to operations because of an intervention (e.g., a lawsuit).

** Denotes "show-stopper" risks.

Industry Perspectives on Commissioning, Licensing, and Other Regulatory Risks

Description of Risk

- Commissioning or Licensing**: Risk of costs of an extended construction period, commissioning delays, or a complete stop to operations because of an intervention (e.g., a lawsuit).
- Regulatory (NRC / DOE): Risks of additional costs arising from a shift in regulations that affects siting, construction, operations, and security.

Risk Rating

- Industry executives rated commissioning risk as a "show stopper". Licensing and regulatory risks were rated 4.3, the highest average score, but this category was interpreted by executives as including commissioning.

Results from Interviews

- Utility executives were emphatic that certain and finite ITAAC approval procedures for commissioning new reactors must be completed before nuclear plant orders can be made. Even after such procedures are completed, they will have to be successfully tested.
- Utility executives also were nearly unanimous in saying that a clearly defined combined Construction and Operating License (COL) process is essential before a single reactor will be ordered. The final procedures must be clear before the utilities will start at all.

Illustrative Quotes

- **Utility Executive**: "All utilities fear a 'Shoreham II'. In a market environment [versus a regulated one], nobody wants to bear the risk of not being able to turn on the unit after you build it...for whatever reason."
- **Utility Executive**: "But, ITAAC (acceptance criteria for commissioning a new plant) is not resolved. Intervenors have too many openings, which drove up costs last time. This is a big issue, a potential show stopper. Who at NRC is on top of this? For example, the emergency evacuation plan was used to halt Shoreham… after it was built! That's a nightmare!"
- **Utility Executive:** "The NRC is backtracking on definition of ITAAC, rather than making progress. This is a deal-killer issue. Nobody wants another Shoreham."
- **E&C Executive:** "NRC would need to expand inspection to modular construction units v. just review of on-site construction."
- **Industry Association:** "I was troubled to see 'programmatic ITAACs' creeping back into the regulatory process in NRC memos [April 2002]. That will keep regulatory uncertainty higher. This is disappointing, frankly."

** Denotes "show-stopper" risks.

Industry Perspectives on Technology / Design Risks

Description of Risk

- Technology / Design: Risks associated with failure or below-grade operating performance due to faulty design of the reactor and balance of the plant system.

Risk Rating

- Industry executives gave technology / system design risks a low rating of 1.5 for light water reactors and a high 4.4 for gas-cooled reactors.

Results from Interviews

- Utilities and engineering firms do not see the GE ABWR and Westinghouse PWR (AP-1000) as carrying much technology risk because the designs are simpler than current light water reactor designs. Construction of ABWRs in Asia is seen as readily transferable for construction in the United States.
- The gas-cooled reactors (PBMR, GT-MHR) remain unproven until commercial scale units are built and tested, most likely with government co-funding. Additionally, utilities expressed concerns about pebble fuel fabrication and handling in operations.

Illustrative Quotes

- **E&C Executive:** "ABWR is in a good position for the U.S. combined Construction & Operating License (COL) process because real units exist (in Japan) for NRC to visit."
- **Utility Executive**: "We have done a detailed side-by-side on the two gas designs and we like the GT-MHR. The size of the unit (~300 MWe) is more attractive: Just four units gets you above 1000 MWe. No pebbles to worry about, fewer handling problems mean more uptime."
- **Utility Executive:** "The PBMR power level per unit is too low at 110 MWe, and what are the economics? Not clear yet? And, it is hard to see that handling 440,000 fuel balls (in multiple units) is simplifying the operational issues."
- **E&C Executive:** "I give a slight edge to the GT-MHR over the PBMR on manufacturing points because they have some of the tooling in place, and they have equipment for fuel fabrication."
- **Equipment Vendor:** "We don't know enough yet about the gas reactors. The power conversion systems (reactor interface, gas turbines, recuperator, etc.) really need to be tested. The small footprint and much lower capital commitments are attractive."

Industry Perspectives on Development / Plant Siting Risk

Description of Risk

- Development / Plant siting: Risks and costs related to getting a new reactor sited and prepared for construction, including specific site designs.

Risk Rating

- Industry executives gave development / plant siting risk a low-to-middle rating of 2.2.

Results from Interviews

- Utilities are very confident of their current sites, and they view the risk of developing a new plant at a current site as being much lower than at "greenfields" sites, which predominated in the last wave of construction. All the utilities stated that new reactors would be built on current sites first.
- However, the Early Site Permit (ESP) process is not fully defined yet and has not been tested. Utilities expressed hope that the ESP process can reduce development time for new plants. They suggested, however, that the draft process does not sufficiently recognize the track record established at current sites and does not distinguish them from "greenfields" sites.
- Three utilities (Dominion, Entergy, and Exelon) entered the ESP process when they announced the specific sites for which they will submit applications to the NRC during the second quarter of 2003.

Illustrative Quotes

Utility Executive: "The ESP process should help. That is why we are entering the pilot effort with the NRC and DOE. Let's see what happens."

Utility Executive: "We have announced that we will file for an ESP (in 2003), but the ESP process stills need to be proven against anti-nuclear protests."

Utility Executive: "We know our sites, and they are popular in their local communities. We provide good jobs, a sound tax base, and clean air. Several communities would support us building another reactor."

E&C Executive: "Utilities are not eager to pay for design and development. They pay for construction."

Industry Perspectives on Construction Risk

Description of Risk

- Construction: Risk of cost or schedule overrun related solely to construction, labor (including strikes), and materials, not regulatory or financing activities.

Risk Rating

- Industry executives gave construction risk a high rating of 4.2 for first units and 3.3 for later units. The first of these ratings was inflated because most utility executives included at least a portion of commissioning risk here, and the second was also high because new plants have not been built in the United States recently.

Results from Interviews

- Utilities remain extremely cautious of starting construction of the first unit and other early units. Capital costs for the first advanced LWRs are expected to be too high (>$1500/KWe) to compete with electricity produced in natural gas plants (especially with gas prices under $3.00 per million Btu). Concern also exists that early new plants will suffer delays in commissioning during construction and after construction is complete.
- Nevertheless, engineering firms involved in units being built in Asia are confident that LWRs can be built in the United States—and at lower prices. These firms note that a pipeline of orders is necessary to take advantage of cost gains from modular construction, which is now being pioneered in Japan.

Illustrative Quotes

E&C Executive: "A skilled workforce (welders, fitters) with nuclear experience in the U.S. is gone, or retiring. This labor bracket needs to see a pipeline of orders to kick start real recruitment and training."

Utility Executive: "The Japanese firms (e.g., Toshiba, Hitachi, Mitsubishi Heavy Industry) will look to play a role on construction here. The modular construction experience is gaining a following throughout industry now."

E&C Firm: "Modular construction is useful, but you need a pipeline of orders, not just one unit, to make it worthwhile."

E&C Firm: "Some U.S. firms are involved in the construction of Asian plants now, and will export that experience over to projects here."

Equipment Vendor: "We firmly believe that reactor suppliers (and engineering companies) have the capability to build the next wave of nuclear plants on time and on schedule. Two ABWRs were built in Japan on budget and on schedule, and the same commitments were made for the construction of two more advanced plants in Taiwan."

Engineering Executive: "We are directly involved in the units being built in Korea. That experience is directly applicable to building units in the United States."

Industry Perspectives on Operating Risk

Description of Risk

- Operating: Risk of increased costs due to poor or inefficient management, operation, and maintenance of the reactor (not including design or technology failings).

Risk Rating

- Industry executives gave operating risk a low rating of 1.9 for light water reactors (LWRs), but a much higher 3.9 for gas-cooled reactors, which are at an earlier stage of development and commercialization.

Results from Interviews

- With the consolidation and mergers of the 1990s bringing much of U.S. reactor capacity into strong hands, utilities have dramatically improved operating efficiencies and reduced fuel replacement outages. Consolidation from 54 nuclear utilities in 1990 to less than 30 by 2001 allows utilities to better manage a larger fleet of units.
- Utility executives do not see the new LWRs as more risky; in fact, the designs are simpler, promising better control.
- Many of these executives are cautiously optimistic that gas-cooled designs will have good operating characteristics, but they are waiting for performance data from full-scale demonstration reactors.

Illustrative Quotes

Utility Executive: "The new (LWR) designs are simpler. We know the control systems and the fuel handling. After the shakedown period, there is no reason the capacity factors should run lower than 90%."

Utility Executive: "Consolidation and management know-how, combined with closing least efficient units, are big advances. Just five years ago, we had 55 nuclear operators in the U.S.; now we only have 27. We are probably headed to 13 operators in a few years, and then possibly to just 6 or 7 after 2010 – 2015."

Utility Executive: "The AP1000 frankly is not that new. The same control systems are being retrofitted onto some current reactors."

Utility Executive: "The ABWR and the AP1000 should reach high operating standards (near a 90% capacity factor); they are known designs. Not clear yet on the gas reactors."

Utility Executive: "Assuming similar construction costs per MWe, the ABWR appears preferable because it has better working record, longer fuel cycles, no steam generators (v. a PWR), and shorter fuel outages."

Industry Perspectives on Fuel Price, Supply Risk

Description of Risk

- Fuel price, supply: Risk of losses and higher operating costs due to fuel price spikes or supply interruptions that lead to downtime or sub-par performance.

Risk Rating

- Industry executives gave fuel price, supply risk the lowest rating, 1.1. Low price, plentiful supplies, and steady, reliable suppliers give nuclear power an edge.

Results from Interviews

- No executives saw fuel supply as a major issue. Utilities are working down their inventories. The fuel blend-down program with the Russians is providing more uranium through 2010 – 2015.
- Stable, reliable allies, such as Canada and Australia, are the leading exporters of uranium supply to the United States. If prices rose again, more mining capacity in those two countries would be activated at known sites, some of it idled now.
- Prices have remained stable ($10 – $15 per pound) since the demise of the Cold War. More mining, conversion, and enrichment capacity can be brought on line if orders pick up.
- Executives see nuclear fuel prices as being much more stable than natural gas prices.

Illustrative Quotes

Utility Executive: "Fuel supply is secure and price appears pretty stable. It would be useful to have one new enrichment plant, which might involve a consortium (e.g., Entergy, Duke, Exelon) combining at, say, Portsmouth site."

Utility Executive: "Fuel is not a problem. We have enough down-blending (of uranium from dismantling warheads) for 10 – 15 years."

Utility Executive: "Known uranium reserves will be able to fulfill the increased demand that will follow a nuclear renaissance. Price will increase, then settle out as exploration is expanded, resources are developed, and uranium is brought to market."

Industry Perspectives on (Long-term Electricity) Demand Risk

Description of Risk

- Demand: Risk of lower revenues because long-term regional demand for electricity does not materialize at a level enabling full utilization of the plant.

Risk Rating

- Industry executives gave demand risk a moderate rating of 2.4, primarily because of the difficulty of predicting demand so many years into the future.

Results from Interviews

- Most interviewees agreed that a glut in gas-fired capacity is being created because nearly 150 – 200 GWe of power capacity is being brought on line from 2001 – 2005, despite cancellations during the recent recession in 2002.
- Executives generally agreed that baseload capacity would be needed after 2010, as hydropower declines and the coal fleet continues to age and to face stiffer emission regulations.
- Several executives commented that the large nameplate capacities of near-term nuclear designs are suitable primarily for baseload situations and that over-the-horizon projections of demand are rather risky, particularly with so much new power supply from gas-fired plants.

Illustrative Quotes

Utility Executive: "Still a lot of uncertainties (licensing, demand, competing supply, disposal), but the U.S. will need baseload power replacement, which is why our firm continues to support nuclear power options."

Utility Executive: "We are definitely in a boom-bust cycle on natural gas, which might take the rest of the decade to work through. Nuclear won't kick in until after 2010."

Equipment Vendor: "We have plenty of gas capacity just built and being built to take us through 2009, roughly. After 2010, the market looks more open, but there are more factors in play: war in the Middle East, fossil supply interruptions, interest rates, terrorist threats not just on nuclear plants, but on gas pipelines, transmission substations."

Equipment Vendor: "It is important to distinguish between the growth in peak demand and the overall growth in demand. Peak demand is served by combined-cycle gas plants. Baseload is served by coal and nuclear plants.

Equipment Vendor: "Large nuclear plants (>1000 MWe) will always be baseload because that is how you run them. Exelon was chasing the PBMR for a while because they saw it as a way to bring capacity on line incrementally to better match load."

Industry Perspectives on Dispatch or Market Risk

Description of Risk

- Dispatch or Market: Risk of revenue loss and of not covering sunk costs because the plant is not competitive given prevailing rates for electricity in local markets.

Risk Rating

- Industry executives gave market risk a low rating of 1.95.

Results from Interviews

- After highlighting the importance of commissioning risk, industry executives made two central points about competitiveness, or market risk:
  - Nuclear plants will run at baseload, rather than playing in the daily market dispatch game.
  - High capital costs (>$1200 per KWe) are the chief concern of potential utility buyers.
- Financial incentives, such as investment tax credits (ITCs), were viewed as a positive measure for addressing this issue, in part.
- Equipment vendors and engineering firms see very positive learning curve gains in the area of construction, including from units built overseas. They believe that building multiple units in the United States would push capital costs under $1200 per KWe fairly quickly, providing the commissioning risks could be dealt with, a step that is critical to making the plant more competitive.

Illustrative Quotes

Utility Executive: "The large capital investment, perceived safety risks, operating costs, reliability challenges, and lack of clean air credits are the principal competitive hurdles. With a continued proven safety record combined with clean air credits, nuclear could emerge as the low cost producer."

Utility Executive: "ITCs and accelerated depreciation would help a lot. Capital cost needs to be <$1200 per KWe (to reduce dispatch risk)."

Nuclear Services Manager: "The ABWR is built in Japan and running well, but nobody has seen a real cost number. The AP1000 design looks solid, but nobody has built one yet. The cost numbers are based on a twin unit order and on 8 reactors total, but no utilities have signed up yet. The proposed French Simplified BWR (SWR-1000) also looks straightforward, but nobody has built that one either (most units in France are PWRs), and the licensing issues are not sorted out."

Equipment Vendor: "Nuclear will run at baseload, not at market dispatch really."

Utility Executive: "All of us face top management worried about earnings dilution when you have that much capital out there for that long during construction of a nuclear plant. The hit to earnings is a top concern."

Industry Perspectives on Transmission Availability

Description of Risk

- Transmission availability: Risk of lost revenues due to transmission constraints reducing off-take of the plant's power production.

Risk Rating

- Industry executives gave transmission availability risk a relatively high rating of 3.0, although individual ratings varied widely due to regional differences.

Results from Interviews

- Industry appeared divided on transmission availability issues, which are regional or even site-specific in nature.
- Transmission capacity is a significant issue for nuclear units because they are inherently large: A twin AP1000 would represent close to 2200 MWe. Gas units are typically sized at 300 – 600 MWe.
- However, several executives noted that the first several new nuclear plants will be located at sites with existing nuclear or coal baseload plants, where transmission capacity is in place. These executives said that transmission constraints will not be a factor in nuclear plants decisions for a decade or more.

Illustrative Quotes

Utility Executive: "And, transmission is a problem. In some states, building transmission lines may be more difficult than building a nuclear plant!"

Utility Executive: "We rate transmission risk low because it is evaluated before we make the build decision."

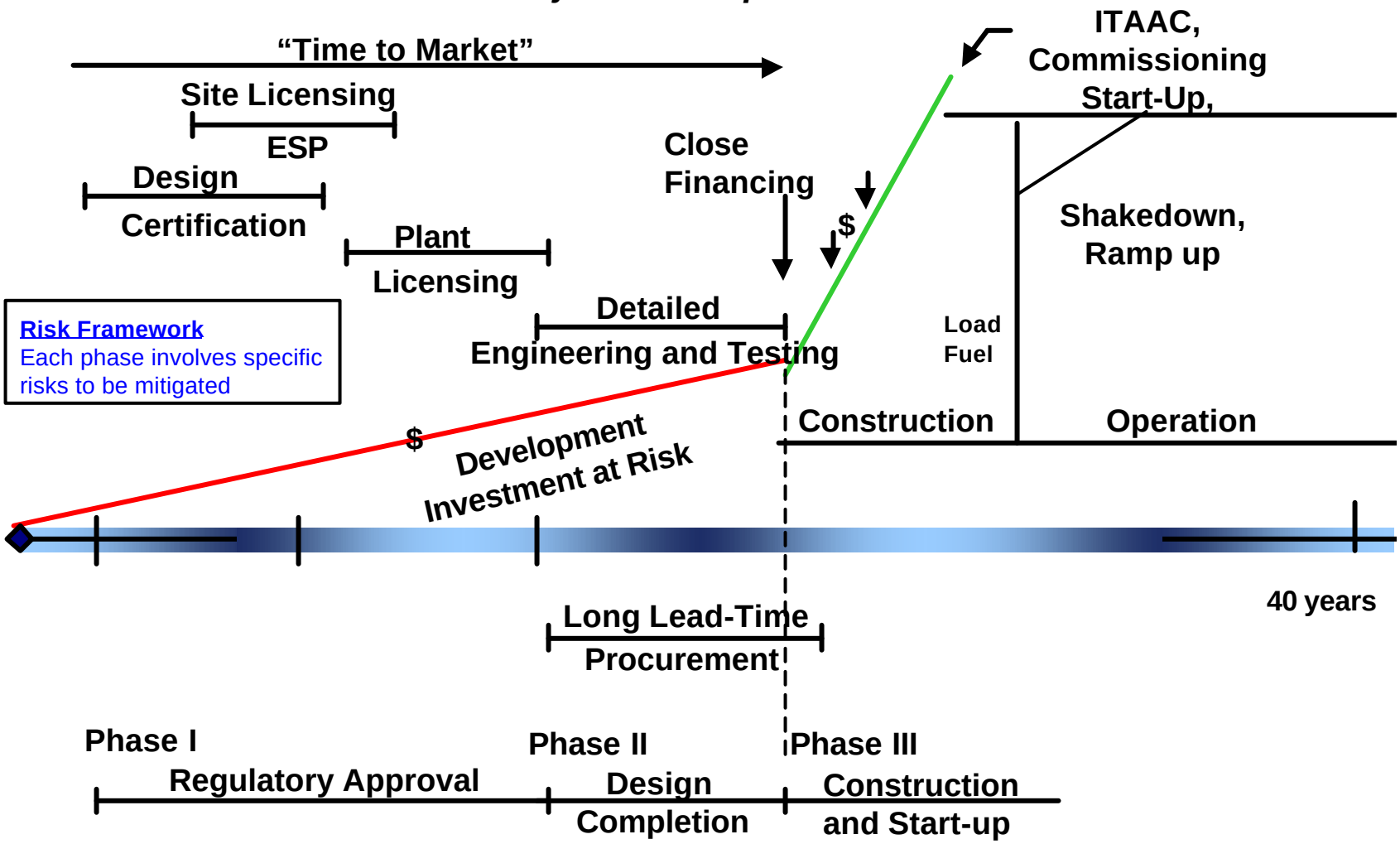
Reactor Vendor: "This risk varies all over the map (1 to 5). The FERC orders are in limbo and the RTOs (Regional Transmission Organizations) are not established yet. Each region is at different stage of deregulation. So, chaos threatens funding for investments in transmission in some bottlenecks, while other regions are OK."

Financial Market's Perspectives: The Project Development Timeline, Capital Formation, Risks, and Current Mitigation Capabilities

Financial Markets' View of Project Development Timeline

- Financial market participants, whether lenders, fixed income security investors (each a provider of debt), or equity investors (shareholders) tend to regard the life cycle of a new nuclear power plant as a financial undertaking with three distinct phases (see next slide for illustration).
  - The development phase, prior to construction, primarily involves design engineering and permitting (licensing) a nuclear facility. During this phase the costs are expected to be less than the expenditures in the construction phase. In a traditional project financing, the cost of development is typically borne by the project's sponsor (the utility or IPP developer). In a corporate financing, these costs are borne by the parent company or by a development subsidiary of a generation company or utility.
  - The construction phase, in which the plant is built, follows the development phase. Expenditures rise rapidly as does the risk exposure of the overall project. Traditionally, project financings by third-party lenders begin funding at this juncture following a closing of the transaction.
  - Sponsors look to outside sources of capital since dollar expenditures can outpace the capacity of the sponsor. Interest on project funding is typically capitalized during this period since the project is unable to generate revenues to replay loans. Corporate financing may be structured with interest paid currently. At the conclusion of construction, financial exposure is at its greatest level during any point in the lifecycle of the project.
  - As construction is completed, the project moves through a period of start-up or commissioning (often called acceptance), in which the facility is operated at gradually increasing rates and all performance criteria are verified. New nuclear facilities must pass the ITAAC process (Independent Testing Analysis and Acceptance Criteria), which is an NRC verification that the facility is able to meet the performance criteria set forth in the design license.
  - Following commissioning, the facility enters the operating phase, which involves a "shakedown" period with power production rising to full design generation levels. For nuclear plants, the shakedown phase may take two years and cover one fuel change out cycle.

Financial Markets' View of Project Development Timeline



Overview of the Financing Structure for a New Nuclear Power Plant

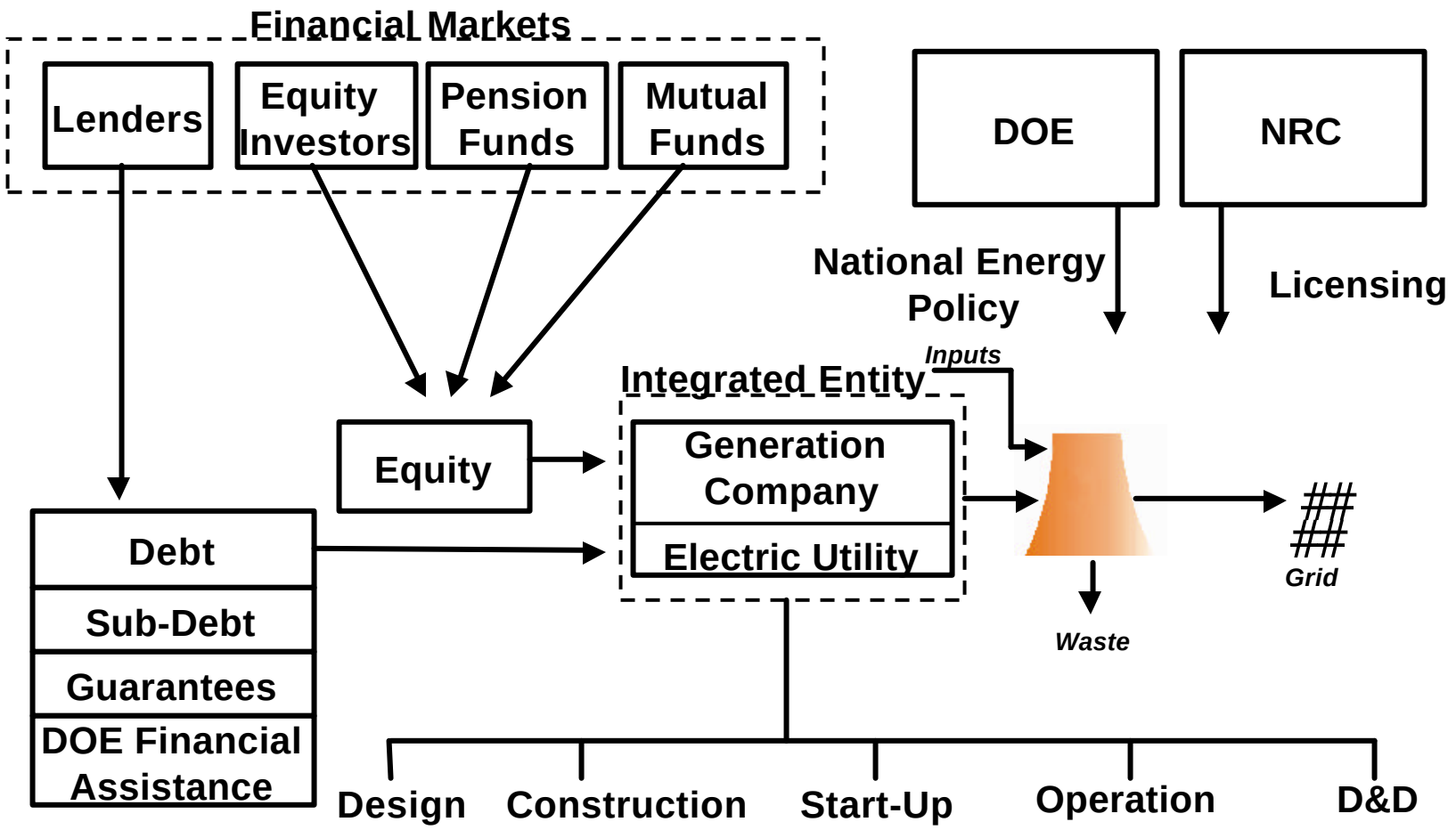
- The diagram on page 3-30 depicts the key players in a new nuclear power plant financing. The diagram does not show an actual financing structure for a new plant.
- An actual financing is likely to be structured as corporate financing in which the power generating company is the borrower with the backing of the parent company of the integrated entity (a corporate structure that combines a power generation company and an electric distribution company). In this approach, power generation assets are treated as being on-balance sheet for accounting purposes. It is likely that the capital structure of the borrower will be comprised of 50% debt capital and 50% equity capital.
- Alternatively, the financing may be structured as a project financing in which a special purpose vehicle (SPV) is the borrower, rather than the corporate parent. In a project financing, the transaction is supported by contractual arrangements between the SPV and various other parties, which typically include the engineering and construction (E&C) contractor, the equipment vendor, and the power purchaser. Project financings are typically structured so as to be without recourse to the parent companies of the entities involved. Rather, lenders are secured by the assets and cash flows generated by the facility being constructed. In this structure, the power generation asset is often treated as off the balance sheet of the power generation company for accounting purposes. Rather, the asset is treated as on the balance sheet of the SPV for accounting purposes. Off-balance sheet non-recourse project financing has been a mainstay approach in the financing of many independent fossil fuel-fired power projects.
- In recent experience, non-recourse project financing for power generation assets has become a much less attractive financing option for power generation financing. Decreases in corporate borrowing spreads (i.e., the margin that lenders require over and above the bank's cost of funds) and increases in project finance borrowing spreads (due to declines in credit quality among deregulated generation companies) has widened the spread differential between these financing options.
  - As the spread on project financings has widened, the cost of "off-balance sheet" financing has become much more expensive relative to the cost of corporate financing.
  - In addition, rating agencies have begun to view project financings as "on-credit" (i.e., on the balance sheet of the corporate parent) despite the off-balance sheet financing structure.
- Faced with much higher borrowing costs and the likelihood that project debt will be treated as corporate debt, corporate financings—which carry the full faith and credit of the corporate entity—are therefore in many cases a preferred financing alternative.

Overview of the Financing Structure for a New Nuclear Power Plant (continued)

Recent Financing Experience

- The high capital costs for new nuclear generating facilities are expected to continue to be a factor in favor of external borrowing, whether on a corporate or a project basis, since it is not likely that even an integrated generating company / utility would have sufficient liquidity from internally generated cash flow to support the cash needs of such a project.
- As noted on the previous page, in recent experience, *non-recourse project* financing for power generation assets has become a much less attractive financing option for power generation financing.
- In the last 12 months, *corporate* acquisition financings for existing power generation assets that have material nuclear related risks have been successful.
  - One example is a financing for Exelon Generating that had a number of nuclear generating assets within the total portfolio of plants in the financing but was not exclusively nuclear. Exelon is considered to have a large and diverse distribution base that generates strong cash flow for the corporation. These factors were cited as critical to the success of the financing.
- The financial market's recent experience in financing existing nuclear generating facilities on a non-recourse basis demonstrated that lenders are not yet ready to accept exposure to risks that have a nuclear element as their central focus.
  - For instance, a recent financing for Entergy's acquisition of three existing nuclear power generating facilities resulted in a structure in which the parent company was asked to provide a
  - guarantee against the operating performance of the plants. This guarantee indicates that the lenders were unwilling to accept this risk based on the track record of the facilities' performance. Lenders were only willing to accept dispatch and energy demand risk on a non-recourse basis (without a parent company guarantee).

Overview of Financing and Construction for a New Nuclear Power Plant



Capital Formation Strategies, Financing Structures for New Nuclear Plants

- When they face the task of raising capital for new nuclear power plants, lenders, fixed income investors, and shareholders are critically concerned with the nuclear risk unique to these facilities and with the large dollar size of the undertaking (>$1 billion).
- While the markets are quite capable of raising multi-billion dollar amounts, the special issues associated with a nuclear facility, including a unique regulatory structure, test the limits of the market's capacity.
- As recent experience on transactions involving existing nuclear plants has shown, to the extent that the financings were structured as isolated nuclear plant fundings, significant numbers of institutions may decline to participate for lending policy reasons rather than credit concerns. Also, some lending institutions have policies that do not permit lending to entities with involvement in nuclear energy. Lenders' concerns about nuclear exposure limits liquidity in the bank market, making it harder for lenders leading a nuclear-related transaction to syndicate a financing to other lenders.

Financing Structures for New Nuclear Plants

- Lenders will likely require parent company guarantees to fully support completion and commissioning risks. The financing is likely to be structured in a conventional manner using the balance sheets of an integrated generation and utility company. Moreover, it is likely that only a well-capitalized entity with a strong cash flow would be willing and able to undertake the expenditures necessary to develop such a facility.
- Most interviewees stressed that off-balance sheet, non-recourse project financing would not be feasible for a new nuclear power plant given the unique risks inherent in a nuclear power facility, the large capital costs of construction, and the limited liquidity in the market.
- Also, because of the untested nature of the new plant designs, the lenders are unlikely to allow these guarantees to fall away during operations.

Construction Arrangements

- Many lenders would prefer to see completion and performance risks mitigated through fixed-price, turn key Engineer-Procure-Construct (EPC) contracts with engineering and construction (E&C) firms.
- In addition, extended warranties from equipment vendors delivering the new reactor design packages may be required to help mitigate the risk of non-performance.

Power Off-take Arrangements

- Given the sheer size of the financial risk of new plants, nuclear power generators are expected to have robust or long-term off-take contracts for the output.
- Generators are not likely to structure the off-take arrangements as a merchant facility since the lenders and equity holders will be looking to lay off some of the operating risk on a utility that needs baseload capacity.

Critical Financial and Business Risks: Development, Construction, and Commissioning

- From the perspective of the financing community, risks differ significantly between the development phase (pre-construction) and construction phase of the project.
- As indicated earlier, certain risks are considered "show stoppers": significant enough and unmanageable from the private sector's viewpoint that, unless resolved, they will prevent a go-forward decision on a new nuclear power generation facility investment. These "show-stopper" risks include the risk of availability of long-term disposal, accident risks (the risk of third-party exposure), and plant commissioning risk.
- As discussed earlier in this section with respect to the nuclear industry, the financial markets view commissioning and other regulatory risks as the most grave concern and the risks most difficult to mitigate using traditional risk management techniques. In large part, this is simply due to the financial community's inability to control these regulatory risks, which—as it is perceived by financial participants—includes a number of components:
  - The risk of changes to the ITAAC process as NRC revisions are in place but have not been finalized.
  - Additionally, the risk that "intervenors" will subject the revised ITAAC process to testing in court once they are issued.
  - The risk that intervenors may sue frivolously thereafter, delaying future projects.
  - The risk of bureaucratic delays in the NRC acceptance criteria process, even after completion and court testing.
- Note that, in a project financing of a conventional power plant, lenders require that all permits are in "final, unappealable form" prior to the funding of construction. The regulatory approach to nuclear power projects cuts directly against this approach in that final regulatory approval cannot be obtained until completion of acceptance testing (commissioning).
- While the NRC has made great strides in developing a more streamlined approach, the regulatory regime is ultimately untested, driving many financial players to the sidelines in search of mitigating cover against this risk.
- Ultimately, it is likely that a well-capitalized industry participant, such as an integrated utility with a diversified portfolio of distribution, will move forward with the the task of permitting a new reactor at a site adjacent to an existing nuclear reactor. No greenfield developments are expected in the next round of new nuclear plants.

Critical Financial and Business Risks: Development, Construction, and Commissioning (continued)

- Design risks associated with the new reactor equipment may be mitigated through a fixed-price, turn key package provided by the equipment vendors with longer-than-usual warranty provisions. Risk mitigation will be limited by the adequacy of liquidated damages and liability limits in these arrangements.
- The difficulty in predicting demand for electricity forward over the 5 – 8 year timeframe of the project development cycle for a new nuclear plant (site permitting, construction, and commissioning) is a major concern. Uncertainty in predicting demand is likely to drive a generator to site a new facility where it is replacing older existing base load plants.
- Construction risks also stand out as a significant concern of many financial participants. In part, this stems from the negative experiences that plagued the industry in the last round of plant construction. The high capital costs of new facilities, while lower than older designs, still stretch the liquidity and borrowing capability of all but the most well-capitalized industry participants.
- While standardized designs should alleviate some degree of concern associated with construction cost overruns and delays, financial participants remain unconvinced simply because this approach does not have a significant track record in a U.S. commercial setting.

Critical Financial and Business Risks: Commercial Operation

- Some risks, such as long-term disposal and ongoing concerns related to regulatory change in law, are critical factors in the operating phase. Many financial participants have cited these as "show-stopper" risks that must be resolved for financial participants to be sufficiently comfortable with the risk profile of the project during commercial operation.
- Other risks are "merely" viewed by the financial community as critical for new nuclear plants early in the next round, such as the cost of power generated. Both equity investors and lenders recognize the risk that the cash flow stream from power generated could be inadequate if power prices are too low in relation to plant cost. As noted earlier, the financial community is likely to require off-take agreements for a substantial portion of the power produced (and will likely buffer risks of inadequate cash flow by requiring the generating company to use corporate, rather than project, finance for new nuclear plants).
- Event risks for a nuclear plant are much larger than they are for a fossil fuel plant (e.g., shutdowns for political reasons, poor operating performance, fuel supply interruptions, accident, *force majeure*, terrorist attacks). Moreover, the "risk of ruin" for a lender to the extent these risks become material is substantial and could bring down a borrower.
- Risks such as demand for electricity, the availability of adequate transmission capacity, and the risk that a plant will be dispatched to operate are not insignificant but are not considered unique to nuclear generation.
- Other, lower-level risks, such as fuel price and fuel supply, are present during operations, but current low market price volatility for nuclear fuel and the availability of adequate fuel supplies from politically stable countries, such as Canada and Australia, render these of less concern to a new project.
- Thus, some potential financial participants are likely to withhold judgment and approval until operating performance becomes well known and others may stand aside of all new nuclear power projects (see next page).

Underlying Economics of Power Production at New Reactors

Background on Existing Facilities

- Existing nuclear facilities in the United States receive high marks for operational improvements and overall low marginal cost of production. Capacity factors have risen sharply from 66% in 1990 to more than 90% today. Improvements in operating performance came from a number of areas, including shorter refueling outages, a problem that plagued the industry when early plants were first operated.
- Lenders are quick to point out that the higher capacity factors are the result of management experience gained over the long history of operating the current fleet.

Factors Affecting New Facilities

- The jury is still out in the financial community when it comes to the economics of power production using new reactor designs, even though the new designs nearest to commercial readiness are evolutionary. In large part, this hesitation arises from concern about the economics of the new designs, including high capital costs for both LWRs and gas-cooled reactors, which have not yet been built and operated in the United States.
- Many financial participants expressed hope that the new designs will equal or exceed the operating performance of the existing fleet.
- New nuclear reactors that have not yet received design certification from the NRC, such as the AP-1000, are hampered by high “first-of-a-kind engineering costs”. These costs will be incurred as detailed plant designs are refined and completed for the U.S. market. Equipment vendors need to recover these costs, but including them in the price to first-time buyers will make the reactors unable to produce power on a cost- competitive basis.
- The first several plants built with the new designs are also viewed as likely to carry elevated EPC costs compared with the “Nth” plants that will be built later, as the learning curve drives down construction costs.
- On a marginal cost basis (i.e., excluding capital costs) these new facility designs appear to be very attractive, and the best are projected to produce power at costs approaching 1¢ / KWh (source: BNFL / Westinghouse).
- A key advantage in evaluating the economics of production is the absence of the large fuel price swings that are characteristic of gas-fired—though not coal-fired—plants. As a result of the lower volatility in fuel prices, the cost profile of a nuclear generating plant is more predictable.
- (Nuclear facilities will be base load plants and decisions to build them will therefore be in markets, for example, where there is not likely to be a high percentage of hydro-electric or coal-fired power production.)

Risk Mitigation Strategies Using Existing Industry and Financial Capabilities

- As discussed in the previous slides, industry and financial firms can draw on a number of risk mitigation strategies to aid in the financing of new nuclear power plants. These strategies have come primarily from the collective experience in financing fossil-fuel facilities for independent power generators, as well as acquisition financings for more recent sales of generation facilities.
- Joint ventures and consortia of generators, construction companies, and equipment vendors building one or a family of new nuclear plants will distribute risk to multiple parties. However, it is unclear whether these entities will be able to provide sufficient levels of financial recourse to fully support the financing at a level sufficient to satisfy lender requirements.
- Robust power purchase agreements will aid in risk mitigation by providing a level of certainty to future power sales and by generating a cash flow stream. However, while these contracts will provide meaningful risk mitigation during operations, they will not play an important role in mitigating licensing, design, and construction risks.
- To address another area of risk, industry could set aside more robust reserves for decommissioning. And, the availability of interim private spent fuel storage sites, such as Private Fuel Storage in Utah prior to the availability of Yucca Mountain, will also help alleviate disposal risk while not entirely eliminating it.

Adequacy of Existing Programs, Capabilities

- While industry and financial firms are capable of mitigating to varying degrees the risks associated with the development of new nuclear power plants, industry and financial community assessments of the risks indicate that it is unlikely that these capabilities will be sufficient to support new nuclear plant development in a timeframe that leads to commercial operation by 2010.
- Existing NE programs to address the “show-stopper” risks (waste disposal, accident, and commissioning) are viewed as valuable by executives from the financial community, but the executives have a significant degree of skepticism and caution: The untried and untested nature of these risk mitigation solutions means that the risks cannot be sufficiently mitigated unless the development of the depository remains on track, Price-Anderson is reauthorized, and ITAAC has been tested and shown to be effective. In the absence of solutions in these areas, the private sector will not move forward on new plants.
- In addition, the business community is concerned that they cannot successfully manage certain economic challenges associated with the first several new nuclear plants without government support.
- With these concerns in mind, we asked industry and financial participants to identify alternative federal financing mechanisms to address the most difficult-to-manage areas of risk.

Alternative Risk Mitigation Approaches with Federal and Private-Sector Augmentation

Alternative Federal Risk Mitigation and Financing Mechanisms

- Executives suggested a number of ideas regarding the role of the federal government in providing alternative financing mechanisms that could help mitigate the most intractable risks facing new nuclear power plants.

Solutions to "Show-stopper" Risks

- An overwhelming number of the suggestions involved mitigation or indemnification against "show-stopper" roadblocks that may delay the completion or the operation of a facility indefinitely. These mechanisms can take many forms from standby facilities to guarantees for repayment or buyout provisions. Reauthorization of the Price-Anderson Act is critical.
- A backstop facility for construction cost overruns and delays would be "hugely helpful". Indeed, many viewed this support equally necessary to a regulatory outtake.

Stronger Policy Support for Nuclear Power

- Executives cited DOE support for new nuclear power plants—even without financing help—as offering additional comfort to the market.

Direct Loans, Guarantees, Standby Credit

- These instruments could be applied to new power plants to deliver low-cost financing and back-up funding to reduce the cost of new plants and improve competitiveness. These financing techniques, when structured as a subordinate or second-lien financing, can also be viewed as a source of "quasi-equity", reducing the risk to the senior lien lender.

Concession Arrangements

- The concession model used in privatizations in many foreign markets is a source of some promising risk mitigation mechanisms provided by host or sponsoring governments. In particular, contract structures that provide for lender step-out rights at par (through a purchase of the debt instruments or a repayment of the loan by the government) in the event of a regulatory change in law provides a vehicle to address regulatory risk. Similarly, through a separate payment mechanism provided by the government—which is triggered in the event of a regulatory change in law, equity investors can be given the option to sell back their equity to the government at a pre-agreed rate of return.

Tax-Exempt Financing For New Nuclear Plants

- Tax-exempt financing for nuclear power is viewed as having some promise. It would provide a lower cost of funding and could be structured either as a private or public undertaking. New legislation would be required.
- The tax-exempt market is well suited to long maturities (up to 40 years), which could prove advantageous for high capital cost facilities with long useful lives.
- Investors in tax-exempt bonds have grown increasingly sophisticated about financing structures and are knowledgeable about construction and completion risks.

"Show-stopper" Risks and Proposed Mitigation Solutions

- As we indicated earlier, three major areas of risks are considered to be "show-stopper" risks, areas that are absolute roadblocks to a go-forward investment decision on new nuclear generating facilities:

Waste Disposal

- All parts of the private sector consider development and construction of the Yucca Mountain long-term waste disposal facility a critical factor in their decisions to develop new nuclear generating facilities. While considerable progress has been made and the facility is closer to becoming a realization now than it ever has been, many participants believe that they will be forced to remain on the sidelines until a conclusive outcome is reached.

Accidents

- Liability for third-party injury, exposure, or property contamination in the event of a nuclear discharge is covered under an arrangement involving the utilities, private insurance underwriters, and the provisions of the Price-Anderson Act, which is scheduled to expire in August 2002, unless extended by Congress. Industry and financial executives consider re-authorization of the Price-Anderson legislation is a lynchpin in the insurance coverage. In the event Price-Anderson is not extended, no new nuclear facility development will occur.

Commissioning

- Industry and financial executives were unanimous in the view that commissioning risk is the most difficult to mitigate using traditional risk management techniques because of the private sector's inability to control certain aspect of it. Without certainty and finite timing in a rigorous Independent Testing, Analysis, and Acceptance Criteria (ITAAC) process, no new plant will be undertaken; the potential to incur additional costs or, in a worst case scenario, have a non-operating plant is an unacceptable risk. Executives noted that certainty and finite timing will not be assured for the first few new plants because the new unproven ITAAC processes will not have been contested.
- The executives were strongly supportive of current DOE efforts in the regulatory area, but recognize that a go-forward decision today would require shareholders and lenders to accept significant exposure to regulatory risk, a step that financial participants are traditionally unwilling to take. Some executives suggested that federal insurance against indefinite delays caused by a lack of certainty in the ITAAC process could mitigate this risk for the first few plants—the ones that will be most exposed to commissioning risks of this type.

Major Risks and Proposed Mitigation Solutions

Major Risk: Regulatory Risk to Timely Completion, Commissioning, or Delay of Operation

Risk of delay or increased costs during construction, commissioning, or operations that is not due to developer / contractor fault, but to delays (a) in final regulatory or licensing approval or (b) resulting from legal injunctions delaying construction or commissioning or halting operations or (c) from change in law which both delays completion and / or increases construction costs or operating costs. Such delays or increased construction costs result in ballooning capitalized interest or unpaid interest costs and diminishing or foregone equity returns to shareholders as cash flows from power sales are interrupted, delayed, or insufficient to cover outstanding debt obligations.

Relative Importance: This is a most significant risk facing new facilities since it can either delay a project indefinitely or cause it to cease operation.

Private Sector Augmentation: Private sector participants are unable to play a meaningful role in mitigating this risk since they do not effectively control the regulatory process or the legal system.

Rationale for Government Role: Since the private sector has no ability to control the regulatory process or the courts, government has the most significant role to play in providing a solution to mitigating these risks.

Mitigation Solutions Proposed

- **Interest Maintenance Facility**

  A federal standby credit facility could be established that would be triggered under regulatory interference or legal injunction. The standby facility would be sized to accommodate up to three years of interest based on the maximum outstanding amount of the loans at the project guaranteed completion date, and drawn on three times.

- **Debt Principal Buy-Down Facility**

  In the extreme case of a regulatory or legal delay not due to developer / contractor fault and if the maximum available coverage under the interest maintenance facility has been utilized already, the facility would have a second tranche that would become available to fund a repayment (i.e., defeasance) of the outstanding principal.

- **Equity Facility**

  In conjunction with the debt principal buy-down facility, a federal equity facility would be available to be drawn to repay shareholder equity at a pre-agreed rate of return.

Estimating the Costs of Proposed Mitigants

The estimated cost of the proposed solution would range from the interest accumulated during delays in construction to the entire principal amount, adjusted for probability. The cost of an equity buy-down facility would be much higher than the cost of a debt facility.

Major Risks and Proposed Mitigation Solutions

Major Risk: High First-of-a-Kind Engineering Costs (FOAKE)

The time and cost of engineering new reactor designs for use in the U.S. market exceeds the risk profile of both the vendors and potential reactor buyers. In the context of the nuclear power industry, where uncertainty about the level of demand for new reactors is coupled with the sensitivity of high capital costs relative to design time and power production costs, vendors face difficulty in passing upfront costs on to purchasers. Based on engineering analysis and experience on plants in Asia, these costs are expected to be significant but decline quickly, creating a major hurdle that is delaying any decision to go forward.

Relative Importance: FOAKE costs pose a significant risk in that they currently represent an insurmountable hurdle.

Private Sector Augmentation: The reactor vendors are limited in their ability to fully fund FOAKE costs by recovering them in the pricing of equipment to power generators. Through a consortia that might commit to the construction of multiple plants, the private sector has proposed sharing a meaningful percentage of these costs.

Rationale for Government Role: Given the short-term nature of this predicament, there is a role for government as a "preferred equity partner" in the development of these facilities.

Mitigation Solution Proposed

- **Government Preferred Equity Facility**

  A federal equity facility would be established to be drawn on to fund or partially fund FOAKE costs. The facility would be sized to address up to worst-case development cost overrun scenarios, based on input from sponsors and independent engineers.

  Repayment of the facility would come from available revenues and would be senior to common equity returns but subordinate to senior project debt, and subject to contractual provisions that may provide for cash flows to be shared between equity and the facility depending on the degree to which it was utilized. Interest rates would be set at the Treasury's borrowing rate and amortization would be on a schedule based on the expected lifetime of the plant. The start of repayment could be triggered when the plant reaches a predetermined capacity factor (e.g., 85%), with a stretch-out provision in case available cash flows were insufficient to fully meet a payment.

Estimating the Costs of Proposed Mitigants

The subsidy cost of this proposed solution would likely be based on an assessment of the borrower's credit risk and the likelihood of timely repayment relative to market factors.

Major Risks and Proposed Mitigation Solutions

Major Risk: High Capital Costs Render Power Output Potentially Non-Competitive

Current industry estimates of the downstream cost of power from newly licensed designs suggest that power production from new nuclear plants may be non-competitive with other base load alternatives, primarily for the first few plants. Estimates of the time required to reach cost-competitiveness are potentially outside of the 2010 new plant target, threatening a delay in go-forward decisions on new orders. Current projections for power prices from early plants using new facility designs range from $0.032 / KWh to $0.042 / KWh (wholesale).

Relative Importance: The ability of these facilities to demonstrate that they can produce power at competitive rates is likely to be a function of time, linking the importance of this issue to the industry's ability to meet the 2010 target for commercial operation.

Private Sector Augmentation: Equipment vendors and construction contractors can provide fixed-priced, turn key packages, the pricing of which will depend, in part, on the level of risk premium that they require. As they become more comfortable with the risks of performance, the level of risk premium will decline over time.

Rationale for Government Role: The government's ability to provide capital at risk free rates or to pass legislation permitting tax-exempt financing would reduce the total project cost of a new nuclear generating facility.

Mitigation Solutions Proposed

- **Federal Direct Loan / Loan Guarantee**

  Most similar to the Department of Transportation's (DOT) TIFIA program under the Transportation Infrastructure Finance and Innovation Act, a federal direct loan could be made available on a competitive selection basis for projects that meet criteria designed to promote the nuclear energy policy objectives of the National Energy Policy. Loans or guarantees could also be available on a senior or subordinate basis for up to some percentage (33%) of the project's eligible costs. Interest rates would be set at the Treasury's borrowing rate and amortization would be tailored to fit the construction profile of the project, allowing for interest holidays and for principal repayment on terms of up to 30 years after project completion.

- **Tax-Exempt Financing**

  The tax-exempt market would provide an attractive source of low-cost funding on terms that are beneficial to the first several nuclear power generating assets, which have long useful lives but are perceived as having elevated risk. Existing law excludes such tax-exempt financing for privately owned nuclear power plants; those that are owned by municipal power agencies may now qualify. It is unlikely, however, that existing municipal power authorities have the financial capability to undertake a new nuclear power plant.

Major Risks and Proposed Mitigation Solutions

Major Risk: High Capital Costs Render Power Output Potentially Non-Competitive *(continued)*

Mitigation Solutions Proposed

- **Tax-Exempt Financing *(continued)***

  New enabling legislation would be tailored to allow for either public or non-profit ownership for a limited number of plants operated by private sector ownership under newly developed private activity bond provisions and volume cap exclusions.

  This option would not alleviate credit concerns associated with early new nuclear plants, but it would provide low-cost alternative financing that can assist in driving down costs of power production.

- **Federal Power Purchase Agreement**

  The government would agree to purchase under a long-term contract a percentage of the output of a given plant at rates that allow for acceptable debt service coverage and a pre-agreed equity rate of return. As plant performance / capacity factor improves, bringing production costs in line with market conditions, the purchase obligation will decline and expire after ten years of commercial operation.

  Power purchased under the facility would be resold into the market. Negative margins, if any, would be deemed the subsidy cost under federal budget provisions.

Estimating the Costs of Proposed Mitigants

The cost of a direct loan would be based on an assessment of the borrower's credit risk, the likelihood of timely repayment and an assessment of recovery rate of the asset in the unlikely event of a bankruptcy. An assumption is made that the government will limit the amount of the direct loan to 33% of the project's total capital cost based on the precedent established in other federal credit programs. The cost of the Federal Power Purchase Agreement solution will vary with the volume and price of power purchased.

Major Risks and Proposed Mitigation Solutions

Major Risk: Construction Cost Overruns

When a new nuclear plant is being built using a new reactor design, unforeseen events or circumstances or the need to make necessary modifications to the design could result in increased costs due to delays or to increases in actual costs. While E&C and vendor-provided warranties may provide a first line of coverage to buy down rising capitalized interest costs and fees, the costs may extend beyond the coverage provisions provided for in contracts.

Relative Importance: Given the high capital costs and the higher level of uncertainty relative to conventional power generating facilities, the risk of cost overruns is at the far end of the risk spectrum within the power industry.

Private Sector Augmentation: The private sector can play a meaningful role in mitigating this risk through the provision of performance guarantees, liquidated damages, and warranty provisions.

Rationale for Government Role: In this instance, given the high capital cost of these facilities and the difficulty the private sector faces in fully mitigating these risks, especially in the early deployment of new facilities, the government can play a meaningful role in providing a backstop against increased costs.

Mitigation Solution Proposed

- **Construction Cost Overrun Facility**

  A federal standby energy credit facility would be established that would be available to be drawn in the event of unforeseen construction cost overruns. The facility would be subordinate to any senior debt financing or to any sponsored corporate financing used to fund the project. The facility would be sized to address worst case overrun scenarios based on input from senior lenders and independent engineers.

  Repayment of the facility would come from available revenues from the sale of power and would be senior to equity returns, subject to contractual provisions that may provide for cash flows to be shared between equity and repayment of the facility depending on the degree to which it was fully utilized (a so-called “leverage trigger”).

Estimating the Costs of Proposed Mitigants

The cost of this proposed solution would be tied to a portion of the construction cost, subject to a cap based on a percentage of the total capital cost. The amount can be limited in negotiation, and would be adjusted for probability. A maximum exposure to the government under a cost overrun facility can be assumed to be up to 33% of total capital cost, based on worst case scenarios in other power plant projects.

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Major Risk: Insurance Needs Exceed Market Capacity

Post 9/11, underwriters either have withdrawn lines or have been unwilling to recommit to existing nuclear insurance pool arrangements. In addition, certain risks, such as onsite cleanup costs related to an other-than-operational accident event are excluded from existing policies. In projects to develop financing for new facilities, this situation could render the transactions unworkable.

Relative Importance: Insurance issues within the nuclear industry are critically important to its ongoing viability. As the industry attempts to add new facilities, it will be important to augment the insurance industry's underwriting capacity and to address uncovered risks. Failure to do so could prevent projects from going forward, negatively impact the cost of financing, or result in onerous penalties from existing shareholders.

Private Sector Augmentation: Private sector insurers will participate as risk underwriters through policy provisions.

Rationale for Government Role: Private sector insurers appear to have reached the outer limits of their underwriting capacity, providing the government the opportunity to play a role as insurer of last resort.

Mitigation Solution Proposed

- **Insurance of Last Resort**

  In a format similar to Price-Anderson, a federal obligation would be established that extends coverage to onsite cleanup risks beyond the policy limitations provided by commercial insurers. This coverage could extend to property damage, third party liability, and workmen's compensation for accident events that are other-than-operational in nature.

Estimating the Costs of Proposed Mitigants

The cost of the proposed solution would vary, based on estimates of the costs of risk-adjusted cleanup scenarios.